A METHOD OF ELECTROCOATING OF SMALL PARTS WITH VARIOUS PAINTS

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BACKGROUND OF THE INVENTION

The present invention relates to a method of electrocoating ("E-coating") of parts within a container with paint.

In the conventional system for processing, and in particular for E-coating, small parts with a suitable outer paint coating, the parts are placed in a metal container such as a barrel, basket, tray or other suitable apertured support. The paint is electrically charged relative to the parts in the container. The filled containers are passed through a series of stations generally including stations for cleaning and pre-treating of the parts prior to passage through a paint station for receiving a suitable paint in an electrocoating process. The paint deposited on the coated parts is then cured, such as by heating the coated parts or exposing them to actinic radiation.

Electrodeposition as a coating application method involves the deposition onto a conductive substrate of a film-forming composition under the influence of an applied electrical potential. Both cationic and anionic electrodeposition are used commercially, with cationic being more prevalent in applications desiring a high level of corrosion protection. Anionic electrodeposition is typically used for decorative applications, particularly where low cost and decorative qualities such as gloss and color are desired.

As noted above, small parts to be E-coated are typically placed in containers, which are agitated by rotation or other movement within the electrocoat material or film forming composition to ensure coating of all parts in the load, to minimize contact or touch points on the final coated part, and to minimize part-to-part stickage. The parts are moved from the electrocoating paint bath onto a separate belt-like conveyor or other support structure to separate the parts and eliminate and minimize contact points that might bind parts together during the curing step. In one conventional system, the coated parts are spread thinly and evenly across the width of the belt of the conveyor or are placed on separate trays in spaced relation for curing. This system not only requires a transfer of the parts from the original container and means to ensure distribution within the belt conveyor system, but when curing is done in an oven, a relatively large oven is needed to provide a total appropriate heating of the parts and the subsequent cooling

thereof. Such systems are thus relatively costly and require additional handling of the parts. If the parts are such that small touch points and only slight bonding may occur, the parts may be passed directly through the oven without movement to reduce the handling and reduced the cost.

In contrast to conventional E-coat systems, in various electroplating systems the articles may be retained within a given barrel or other like container and moved directly into an oven without the necessity of removal and then reorganizing of the separate parts into a suitable container. In such systems, the parts are plated with a conductive metal. The parts are placed in a container for immersion within appropriate electroplating tanks and then transferred within the container into an oven system. This system may provide for rotating of the parts within the plating portion of the unit as well as the oven portion because the plating of the container is acceptable. Significantly, in the electroplating industry the oven is used to simply dry the parts, whereas in an electrocoat system the oven is used to cure the coating deposited on the parts. Thus, notwithstanding such standard usage in the plating art, the considerations within the painting lines have avoided the application of such systems in E-coating. In summary, the practice of the electroplating art has never been applied to the art of paint coating using E-coating processes.

SUMMARY OF THE PRESENT INVENTION

The present invention is thus particularly directed to a system wherein the parts are contained within a suitable container and maintained within the container during the coating and the curing of the paint coating. The term "parts" as used herein refers to relatively small metal parts that are handled in bulk and which are conventionally assembled in a container during electrocoating. This includes, for one example, nuts, bolts, screws, other fasteners, such as those used in the manufacture of automobiles and airplanes. In accordance with the present invention, the containers are agitated as by rotating or the like during the curing step, such as in passing through an oven or during exposure to actinic radiation. Applicants have found that with the rotating or continued movement of the painted parts and particularly with a tumbling-type action of the parts, the contact between the parts is such that there is effectively a minimization in the contact or touch points of the adjacent parts and a substantially complete avoidance of

sticking or bonding of parts to parts, resulting in the maintaining of essentially separate coated parts and providing an improved coating over each of the parts. In such systems, it may be desirable to recycle the part with an initial coat through the line to apply a second coat which is similarly passed in the containers through the coating section and the curing section to further essentially eliminate any contact points exposure of contact points or connection of the parts to each other.

The present inventors in the developing of an e-coating line apparatus have found that in fact the e-coating process can be completed with the container transferred directly to the curing step without forming an insulating barrier coating within the barrel or other container which prevents high quality coating of parts at least for over a substantial number of cycles. In fact, an initial thin coating of the container is made in a normal coating processing. However, the coating does not interfere with subsequent part coating within the container. In fact it is found that with present day paints and technology a barrel can be operated for a substantial number of cycles before the coating reaches a level which interferes with the high quality coating of the parts within the barrel.

The present invention is particularly directed to the systems wherein the parts are contained within a suitable container and maintained within the container during the paint coating process and the curing process. As previously noted the container may be a barrel, tray, basket, rank or like member which can be moved within the coating cycle line and within the curing line. Thus the container must be at least subject to agitation as by controlled rotating or like movement in passing through the curing stages for a period sufficient to minimize or avoid significant touch points or part bonding. Applicants have found that with the rotating of the painted parts and particularly a tumbling type action of the parts which occur in connection with a barrel, appropriately constructed baskets, trays or the like, the contact between the parts is such that there is effectively a minimization of the contact or touch points of adjacent parts and a substantially complete avoidance of parts sticking to each other. Thus, the new system provides separate coated parts with highly effective coatings and provide an improved system of coating and curing of painted parts. Even as the barrel coating increases, the barrel may be used with recycling of the parts within the barrel through the line to apply a second coat if the

original coating does not reach required specifications. In the overall systems, the new continuous line system provides a highly improved final product at a significant reduction of cost and with an increase in production.

The parts are similarly treated within the coating line and the oven line with the rotation or other appropriate movement of the parts relative to the container and each other during the curing cycle. The system has been found to produce a highly effective single line processing with complete coverage of the parts.

As noted previously, various systems can be applied to produce a necessary movement of the container within the curing stage as well as within the coating stage. Gear systems coupled to the container and then to an outer driven gear or a rack unit have been used in prior art coating stages, but not during the curing stage.

In summary, the present invention is particularly directed to an inline system for electrocoating of parts, with the parts held within a container including a barrel, basket tray apertured members or other suitable materials during the coating process, and the container with parts therein is then passed directly into a curing section with the parts held within the same container for the curing of the parts with movement of the parts to minimize contact points and without joining of the parts to each other. The curing section may include an oven or other conventional curing means, such as UV lamps with the container rotating or otherwise moving during the exposure to the UV radiation.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings provided herewith disclose a preferred method of electrocoating a plurality of parts within a containing unit for coating and then curing of the parts within the single container.

Fig. 1 is a simplified view of the processing line for electrocoating of small parts contained within rotatable barrels;

Fig. 2 is a separate enlarged view of the rotatable container shown in Fig. 1 and containing small parts;

Fig. 3 is a top plan view of the barrel and barrel support for processing through the single line;

Fig. 4 is a side view of the container shown in Fig. 3;

Fig. 5 is an end view of the barrel shown in Figs. 2 and 3;

Fig. 6 is a view showing a drive system for rotating the barrel, and

Fig. 7 is a view of an alternate structure for supporting of a barrel during passing of the barrel through a single line including a coating section.

DESCRIPTION OF ILLUSTRATED EMBODIMENT

Referring to the drawings in particularly to Figs. 1 and 1a, an e-coating paint 1 is illustrated for coating of small parts 2 with a protective paint layer 3. A plurality of parts 2 are placed in each of a series of containers, shown in Figs. 1 and 2 as barrels 4. The barrels are mounted within a suspension support unit 5 for individual supporting and moving of the barrels through line one. In the illustrated embodiment a hoist conveyor system 6 carry and move the support unit 5 with the barrel 4 in place throughout the length of the stations of the e-coating line 1. Line one includes a first paint coating section 7 followed by a heat curing section 8. The support units 5 are selectively located within the coating section 7 which may include various processing units such as pre-treating units in which the parts are appropriately conditioned for receiving of a coating of paint within a coating unit 10. After receiving of an appropriate coating the support unit with the attached barrel is picked up by a hoist unit 6 and transferred and deposited in one or more of the curing ovens 8a. The use of a hoist system provides for treatment of certain parts depending upon the part and the coating to be applied. In all instances each of the barrels 4 is passed through the coating section 7 to coat the parts within the barrels and then transferred directly to one or more of the curing ovens 8a. A hoist unit is then operative to remove the support unit 5 and the attached barrel 4 to a discharge location 9 through which the unit is transferred to a discharge location not shown in the drawings. The use of a hoist system eliminates the necessity for providing direct sequential movement of the barrels in line through each station of the respective coating section 7 and the curing section 8.

In summary, however, in all instances the parts 2 are transferred sequentially through the coating section 7 and then directly through the heat curing section 8 to provide for coating of the parts generally in condition for discharge from the coating system. As more fully developed here and after under certain conditions and product lines it may be desirable to recycle the units or the barrel through the coating line and it

may be automatically of course created through appropriate transfer from the discharge line 11 to the entrance position 12 of the line one.

The hoist 6 is a conventional well known unit which is connected to a carriage 13 movably mounted on a supporting beam structure 14 extending throughout the length of the line one. A support member consisting of a vertical rod is fixed to the carriage 13. A lift unit shown as an L-shaped member 14 on a supporting rod 15. The lower and raising of the unit 14 is controlled by interconnection within the support rod 15 in accordance with well known construction.

The L-shaped member includes a leg 14a which is operable to engage a lift unit secured to the barrel unit 4 as more fully developed here and after. The lift units deposit the various barrel units in appropriate stations. As the sequence does not require alignment with each station, the hoist unit can move a load any number of stations available between the adjacent lift hoist units.

Each barrel unit is transported in sequence through the coating line 7 and then through the curing line 9 before removal from the line for discharge of the parts.

Thus the coating section as shown includes a substantial number of different stations as does the curing section 8. The hoist system allows the precise location of the various devices and appropriate locations within the line.

The hoist system also provides for lifting of the final product and transferring it into the discharge location 9. The barrels 4 are loaded with the parts 2 at the inlet end of the line shown to the left end thereof. The load sequentially passes through the designed pre-treating stations and at least one coating station and then one or more of the oven units 8a. The system permits a substantially continuous flow through the system with the coated parts completely finalized in the. Thus the parts may be removed and new parts introduced.

As noted with the present invention, the interior of the barrel structure is coated within a inner coating surface during a coating process without parts. The initial coating is found to be thin and does not interfere with subsequent use of the barrel for coating of parts. After a number of cycles through the system, generally a plurality of cycles depending on the paint and the like it may be necessary to remove the barrel, clean the

inner surface and recoat with the thin coating to maintain the desired conductivity of the barrel relative to the parts and the coating paint.

Referring particularly to figs. 3-5 a view of a barrel interconnected to the support structure 5 is illustrated in a preferred construction.

The barrel 4 is a apertured structure having a removable cover allowing access to the barrel. Parts 2 are deposited within the barrel. Rotation of the barrel will result in a tumbling effect by raising of the parts allowing them to drop downwardly through the coating paint to provide continuous coverage of the surfaces. More fully developed here and after.

The barrel is rotatably mounted within the support unit 5.

In particular the barrel includes the end walls 27 and 27a which close the opposite ends of the barrel. Support shafts 28 and 28a are secured to the end walls and project outwardly on a common axis. The opposite end shafts are journaled in depending frame members 29 and 29a of support 5. The U-shaped support includes an upper beam 30 with the frame 29 and 29a secured to the underside of the beam extending downwardly to the opposite ends of the barrel. Each of the frames includes a plate abetting the 30 and including depending legs 31 and 32 depending downwardly and terminating at the lower end in a interconnecting bearing unit 33 the bearing unit supports the corresponding shaft 28. The top beam 30 includes L-shaped laces welded to and rigidly affixed to the beam 30. It provides spaced horizontal surfaces for receiving corresponding arms of the hoist unit. The upper cross beam protecting support members with two projecting support members 35 to the one end of the barrel and a single centrally located similar support beam 35a to the center of the opposite unit bearing.

The one support frame faced outwardly at the end of the barrel as shown in fig. 3. A driven gear or a sprocket 37 is firmly clamped and secured to the adjacent barrel wall. The diameter of the gear 37 is greater than the diameter of the barrel with the outer tooth edge of the gear projecting outwardly and upwardly toward the support beam 30. A small pinion gear 38 is supported by a shaft journaled within an opening in the cross brace beam of the depending frame drive dear or sprocket 40 is secured to the outer end of the shaft 38a and provides a rotary input to a gear train for rotating of the barrel within

the several stations of the line, with at least one in the coating section and one in the heating section.

With the barrel located in the lower position as shown in Fig. 1, gear 40 is aligned with a driven gear 40a at each selected station throughout the respective length of the line. A first set of drive drafts 41 span the selected number of lines in the coating section and connects the driven gears. A second set of drive shafts 42 extends from the adjacent end of the coating line throughout the length of the curing line inclusive of the curing ovens. Each of the lines of drive shafts 41 and 42 is coupled to a related motor 41a and 42a which is secured to the base structure and rotates the drive shafts. Operation of the motors cause rotation of the gear units at the respective stations to rotate the barrels.

Thus, the parts are loaded into the barrel at the entrance end of the line moved through the line by the operation of the hoist units. Movement through the coating section 7 provides for the appropriate treating and coating of the parts with the paint coating. Movement through the ovens cures the coating to provide an effective protective cover thereto, with essentially no exposure of the metal part.

After the thorough coating and curing of the parts, the barrels are discharged at the discharge end of the line. With the parts removed, the barrels are recycled to receive a new load.

In some instances as previously noted it may be desirable to recycle any given batch to ensure the continuity of the coating on the parts.

Further after a certain number of cycles have occurred, the conductivity of the barrel is monitored and if necessary the barrels are processed to remove any coating build up within the barrel wall which interferes with the conductivity thereof, and a new thin coating applied.

The hoist system provides for the desired operation with a continuous inline movement of the system and without a necessity of pre-removal of the parts prior to the very final processing thereof.

The system with the in-line curing of the coating provides a significant simplification in the total system in contrast to the conventional system wherein, depending upon the structure of the parts, the final coated parts are removed from the barrel or other container prior to placement within the oven and are spaced on a

conventional conveyor in accordance with known practice. In all prior art systems, the parts are not rotated or moved relative to each other.

The electrodepositable paint used in the practice of the present invention comprises an acidified aqueous dispersion of the following components:

(a) an ungelled ionic, preferably a cationic resin;

(b) a curing agent having at least two functional groups which are reactive with (a); and

(c) a pigment.

By "ungelled" is meant that the polymer is substantially free of crosslinking and has an intrinsic viscosity when dissolved in a suitable solvent. The intrinsic viscosity of a polymer is an indication of its molecular weight. A gelled polymer, on the other hand, since it is of essentially infinitely high molecular weight, will have an intrinsic viscosity too high to measure.

With reference to the preferred cationic resin (a), a wide variety of cationic polymers are known and can be used in the compositions of the invention so long as the polymers are "water dispersible," i.e., adapted to be solubilized, dispersed or emulsified in water. The water dispersible resin is cationic in nature, that is, the polymer contains cationic functional groups to impart a positive charge. Preferably, the cationic resin (a) also contains active hydrogen groups.

Examples of cationic resins suitable for use in the compositions of the invention include those derived from epoxy resins, such as amine salt group-containing resins such as the acid-solubilized reaction products of polyepoxides and primary or secondary amines such as those described in U.S. Patent Nos. 3,663,389; 3,984,299; 3,947,338; and 3,947,339. Usually, theses amine salt group-containing resins are used in combination with a blocked isocyanate curing agent. The isocyanate can be fully blocked as described in the aforementioned U.S. Patent No. 3,984,299 or the isocyanate can be partially blocked and reacted with the resin backbone such as is described in U.S. Patent No. 3,947,338. Also, one-component compositions as described in U.S. Patent No. 4,134,866 and DE-OS No. 2,707, 405 can be used as the cationic resin (a). Besides the epoxy-amine reaction products, resins can also be selected from cationic acrylic resins such as those described in U.S. Patent Nos. 3,455,806 and 3,928,157.

Besides amine salt group-containing resins, quaternary ammonium salt group-containing resins can also be employed. Examples of these resins are those which are formed from reacting an organic polyepoxide with a tertiary amine salt. Such resins are described in U.S. Patent Nos. 3,962,165; 3,975,346; and 4,001,101. Examples of other cationic resins are ternary sulfonium salt group-containing resins and quaternary phosphonium salt-group containing resins such as those described in U.S. Patent Nos. 3,793,278 and 3,984,922, respectively. Also, cationic resins which cure via trans-esterification such as described in European Application No. 12463 can be used. Further, cationic compositions prepared from Mannich bases such as described in U.S. Patent No. 4,134,932 can be used.

The resins to which the present invention is particularly effective are those positively charged resins which contain primary and/or secondary amine groups. Such resins are described in U.S. Patent Nos. 3,663,389; 3,947,339; and 4,115,900. In U.S. Patent No. 3,947,339 a polyketimine derivative of a polyamine such as diethylenetriamine or triethylenetetraamine and the excess polyamine vacuum stripped from the reaction mixture. Such products are described in U.S. Patent Nos. 3,663,389 and 4,116,900.

The cationic resin (a) described immediately above is typically present in the compositions in amounts of 1 to 60 weight percent, preferably 5 to 25 weight percent based on total weight of the composition.

As previously indicated, the composition of the present invention further comprises a curing agent (b) which contains at least two functional groups which are reactive with the cationic resin (a). The preferred curing agents for use in the compositions of the invention are blocked organic polyisocyanates. The polyisocyanates can be fully blocked as described in U.S. Patent No. 3,984,299 column 1, lines 1 to 68, column 2 and column 3, lines 1 to 15, or partially blocked and reacted with the polymer backbone as described in U.S. Patent No. 3,947,338 column 2, lines 65 to 68, column 3 and column 4, lines 1 to 30. By "blocked" is meant that the isocyanate groups have been reacted with a compound so that the resultant blocked isocyanate group is stable to active hydrogens at ambient temperature but reactive with active hydrogens in the film forming polymer at elevated temperatures usually between 90°C and 200°C.

Suitable polyisocyanates include aromatic and aliphatic polyisocyanates, including cycloaliphatic polyisocyanates and representative examples include diphenylmethane-4,4'-diisocyanate (MDI), 2,4- or 2,6-toluene diisocyanate (TDI), including mixtures thereof, p-phenylene diisocyanate, tetramethylene and hexamethylene diisocyanates, dicyclohexylmethane-4,4'-diisocyanate, isophorone diisocyanate, mixtures of phenylmethane-4,4'-diisocyanate and polymethylene polyphenylisocyanate. Higher polyisocyanates such as triisocyanates can be used. An example would include triphenylmethane-4,4',4"-triisocyanate. Isocyanate-prepolymers with polyols such as neopentyl glycol and trimethylolpropane and with polymeric polyols such as polycaprolactone diols and triols (NCO/OH equivalent ratio greater than 1) can also be used.

The polyisocyanate curing agents are typically utilized in conjunction with the cationic resin in amounts from 1 weight percent to 65 weight percent, preferably from 5 weight percent to 45 weight percent, based on the total weight of the composition.

The solids content of component (c) in the composition is typically less than 50 weight percent, preferably less than 10 weight percent based on total solids content of the composition. Also, the solids content of component (c) in the composition is typically at least 1 weight percent, preferably at least 3 weight percent, and more preferably at least 5 weight percent based on total solids content of the composition. The solids content of component (c) in the composition may range between any combination of these values, inclusive of the recited values.

The electrodepositable compositions of the present invention are in the form of an aqueous dispersion. With reference to the electrodepositable compositions, the term "dispersion" as used herein is believed to be a transparent, translucent or opaque resinous system in which the resin is in the dispersed phase and water is in the continuous phase. The average particle size of the resinous phase is generally less than 1.0 and usually less than 0.5 microns, preferably less than 0.15 micron.

The concentration of the resinous phase in the aqueous medium is at least 1 and usually from about 2 to about 60 percent by weight based on total weight of the aqueous dispersion. When the compositions of the present invention are in the form of resin

concentrates, they generally have a resin solids content of about 20 to about 60 percent by weight based on weight of the aqueous dispersion.

Electrodeposition coating compositions of the invention are typically supplied as two components: (1) a clear resin feed, which includes, generally, the cationic resin (a), i.e., the main film-forming polymer, the curing agent (b), and any additional water-dispersible, non-pigmented components; and (2) a pigment paste, which generally includes one or more pigments, a water-dispersible grind resin which can be the same or different from the main-film forming polymer, and, optionally, additives such as wetting or dispersing aids. Electrodeposition coating composition components (1) and (2) are dispersed in an aqueous medium which comprises water and, usually, coalescing solvents, to form an electrodeposition bath.

The electrocoating composition of the present invention has a resin solids content usually within the range of 5 to 25 percent by weight based on total weight of the electrocoating composition.

As aforementioned, besides water, the aqueous medium may contain a coalescing solvent. Useful coalescing solvents include hydrocarbons, alcohols, esters, ethers and ketones. The preferred coalescing solvents include alcohols, polyols and ketones. Specific coalescing solvents include isopropanol, butanol, 2-ethylhexanol, isophorone, 2-methoxypentanone, ethylene and propylene glycol and the monoethyl, monobutyl and monohexyl ethers of ethylene glycol. The amount of coalescing solvent is generally between about 0.01 and 25 percent and when used, preferably from about 0.05 to about 5 percent by weight based on total weight of the aqueous medium.

As discussed above, a pigment composition and, if desired, various additives such as surfactants, wetting agents or catalyst are included in the dispersion. The pigment composition may be of the conventional type comprising pigments, for example, iron oxides, strontium chromate, carbon black, coal dust, titanium dioxide, talc, barium sulfate, as well as color pigments such as cadmium yellow, cadmium red, chromium yellow and the like. The pigment content of the dispersion is usually expressed as a pigment-to-resin ratio, i.e., the weight ration of (c) to (a) + (b). In the practice of the invention, when pigment is employed, the pigment-to-resin ratio is usually within the range of about 0.02 to 1:1. The other additives mentioned above are usually in the

dispersion in amounts of about 0.01 to 3 percent by weight based on weight of resin solids.

The compositions of the present invention can be applied by electrodeposition to a variety of electroconductive substrates especially metals such as untreated steel, galvanized steel, aluminum, copper, magnesium and conductive carbon coated materials. The applied voltage for electrodeposition may be varied and can be, for example, as low as 1 volt to as high as several thousand volts, but typically between 50 and 500 volts. The current density is usually between 0.5 ampere and 5 amperes per square foot and tends to decrease during electrodeposition indicating the formation of an insulating film.

After the coating has been applied by electrodeposition, it is cured usually by baking at elevated temperatures such as about 90° C to about 260°C for about 1 to about 40 minutes..

Thus although the invention may be readily applied to all e-coat paints, optimum results are received with paint of particular characteristic.

As previously discussed the barrel may be replaced with baskets, trays or other like elements which can appropriately support of the parts while providing for movement of the parts within the container.

An alternative conveyor structure which has been designed and used for e-coat paint line is a subject of a pending patent application entitled "A Grounding System for Rotating Fixtures in Electrically Conductive Mediums" with Serial No. 09/997,486 which was filed on November 20, 2001 and is owned by SST, Inc. of Sturgeon Bay, WI.

Referring particularly to Fig. 6, a push-slide conveyor 50 is illustrated supporting a plurality of barrel containers 51 including parts 51a for movement through a processing line 52. The conveyor 50 includes a rail 53 wherein individual slide bars 54 are slidably mounted. Each bar 54 has upstanding longitudinally spaced support members 55. A load bar unit includes a rectangular frame 56 with spaced support rods 57 projecting outwardly and resting in the slide support members 55 to the opposite side of the line 52. The frame 56 includes a centrally located rotating shaft 57. The shaft 57 extends throughout the width of the frame and overlies the coating and curing line. The barrel 54 includes opposite end shafts 58,58a projecting parallel to the rotating shaft 57. Chain and sprocket unit 59 and 59a are secured to the opposite ends of the shafts 55,55a barrel

in alignment with corresponding sprockets on shaft 57. Each unit includes a sprocket fixedly secured to the rotating shaft and a second sprocket secured to the aligned end shaft of the barrel. The sprockets preferably are interconnected by a suitable special link chains. The rotating shaft 57 is connected through the frame 56 and conveyor 50 to the system ground and provides for direct grounding of the barrel 56. Parts 51a within the barrel are immersed within the coating paint which is connected to the opposite side of the power supply.

In this embodiment, the total system is arranged such that the barrels 51 move through the coating line 52a and then through the oven line 56. The curing line 52b is located above the coating line 52a with a transfer unit 60 at the opposite ends of the line to provide for the transfer of the barrel units and the associated load bar unit from the coating section to the oven section.

In both the coating section and the oven section, rack assemblies are provided for mating with a sprocket on the rotating shaft 57 on the load bar unit to affect rotation of the shaft and thereby the barrel 4. Generally, in the coating line, a moveable rack 61 is secured to the conveyor structure and moves with the movement of the barrels from one station to the next to eliminate or control rotation of the barrel during the transfer.

Within the oven unit, a fixed rack may be provided extending along the oven section. When the load bar unit moves over and parts the rack, the sprocket 59 rotates, and the barrel 51 rotates. The parts 51a are moved within the barrel, preferably with a tumbling action to provide final treatment of the coating.

The barrel and load bar units are unloaded at the end of the oven and cooling unit to complete the coating cycle.

Other transport and conveying systems used in prior e-coating as well as electroplating may be used in the present unique method of e-coating parts with the parts retained in a container for movement through the total line.

The present invention provides a unique on line coating and curing of paint coating applied to parts mounted within a container permitting relative movement of the parts within the container.